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The Commonwealth of Massachusetts

Department of Labor and Industries

DIVISION OF OCCUPATIONAL HYGIENE

OCCUPATIONAL HEALTH HAZARDS IN MASSACHUSETTS
INDUSTRIES

WOOLLEN AND WORSTED GOODS MANUFACTURE

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FOREWORD

The survey described in the following report is one of a series of industrial health studies conducted by the Division of Occupational Hygiene of the Massachusetts Department of Labor and Industries, in co-operation with the Works Progress Administration, as part of the Industrial Chemical Survey Project, W. P. A. No. 65-14-6060. This survey was supervised by Hervey B. Elkins, chemist of the division. The purpose of this work is to secure, as a basis for constructive preventive effort, knowledge of the extent and manner of use of the more important potentially hazardous chemicals in the industries of the Commonwealth. The wholehearted assistance of the establishments visited is gratefully acknowledged.

THE SERVICES OF THE DIVISION OF OCCUPATIONAL HYGIENE ARE AVAILABLE ON REQUEST IN CONNECTION WITH MATTERS PERTAINING TO THE HEALTH OF INDUSTRIAL AND MERCANTILE WORKERS.

OCCUPATIONAL HEALTH HAZARDS IN MASSACHUSETTS INDUSTRIES

V. WOOLEN AND WORSTED GOODS MANUFACTURE

A total of 26 mills employing 32,600 persons (of whom 12,400 were females) were visited in this survey. These may be classified as follows:

Worsted goods	6	Worsted and woolen	6
Woolen goods	11	Wool scouring	3

All the establishments visited carried compensation insurance. One employed the full time services of a physician, and another group of four mills shared a full time physician. Three other mills employed physicians on a part time basis, and ten had one or more full time nurses. Seven establishments had pre-employment physical examinations, although in a majority these affected only male workers. Three had periodic physical examinations for certain groups of employees.

Complete data on all the chemicals used were obtained from two mills, but in the majority of cases information on a selected list of substances only was sought. Special emphasis was placed on the use of solvents, as these may have systemic as well as local effects, and many of them are relatively new to this industry.

The number of mills using the more important solvents, together with a few other compounds of interest from the industrial hygiene viewpoint, are shown in the following table:

Substance	Amount Used		Process
	Large	Small	
Acetone		2	Spotting
Ammonia	9		Dyeing, fulling, scouring
Carbon Tetrachloride	4	7	Spotting, moth proofing, analysis
Chloroform		1	Spotting
Chromium Fluoride		2	Printing
o-Dichlorobenzene	2	1	Fulling
Ethylene Dichloride	4	2	Moth proofing—tar remover— spotting—soap assistant
Formaldehyde	3	5	Dyeing
Formic Acid	5	1	Dyeing
Hydrogen Sulfide		2	Dyeing
Hi-flash Naphtha	2		Fulling
Ether	1	12	Spotting
Oxalic Acid	1	2	Printing
m-Phenylene Diamine		2	Dyeing
Pyridine	3		Dyeing
Sodium Carbonate	26		Scouring, fulling
Sodium Dichromate	15	1	Dyeing
Sulfur Dioxide	1		Bleaching
Xylene	4	1	Fulling
Hydrogen Peroxide	2	1	Bleaching
Benzol	1	1	Scouring, belt shop
Dichlorethyl Ether		2	Soap assistant

These may be divided into water soluble substances used chiefly in dyeing operations, and solvents used as cleaning agents. The former are mainly irritants and produce many cases of dermatitis. Special mention was made of trouble of this type resulting from sodium carbonate, chromates, and oxalic acid. Hydrogen sulfide, pyridine and m-phenylene diamine were used in a few plants but no unfavorable experiences with these materials were reported.

AMMONIA

In two plants air analyses were made for ammonia in scouring processes. The results are shown in the following table:

Plant	No. Samples	Ammonia Found—Parts Per Million Parts of Air			Ventilation
		Max.	Min.	Avg.	
No. 1	4	120	30	75	Natural
No. 2	4	30	6	13	Local exhaust

The effect of the local exhaust ventilation in Plant No. 2 is shown in the much lower concentration of ammonia found. It is generally believed that concentrations of over 100 parts per million lower the resistance to respiratory infections.

SOLVENTS

The seven groups of air analyses for solvents used for various purposes are summarized in the following table:

No.	Process	Vapor Determined	No. Samples Taken	Concentration Found PPM			Max. Safe Conc.
				Max.	Min.	Avg.	
1	Fulling	Dichlorbenzene	3	150	15	75	-
2	Fulling	Dichlorbenzene	5	270	10	140	-
2a	Fulling	Total vapors	5	325	25	160	-
3	Fulling	Hi-flash Naphtha	6	310	85	170	100-200
4	Fulling and scouring	Benzol	3	15	5	10	100
5	Scouring	Ethylene dichloride	3	5	0.4	4	100
6	Oil determination (laboratory)	Carbon tetrachloride	2	55	55	55	100
7	Leather belt mfg.	Benzol	4	515	160	325	75

In Nos. 4 and 5 the vapor concentrations found were negligible. In No. 6, while an appreciable concentration was found, the process was intermittent and the hazard was slight.

In the belt manufacturing process using benzol a definite hazard was found, although the exposure to the concentration found was not continuous. This situation was remedied by the elimination of benzol from the process.

The fulling operations (Nos. 1-3) using paint and tar remover were the only typical mill processes in which exposures to high vapor concentrations were found. While these exposures are not, as a rule, encountered every day, they occur regularly in the average large mill. The only solvents found to be used in quantity in these operations were xylol, hi-flash naphtha, and o-dichlorbenzene. Dichlorethyl ether and carbon tetrachloride have been used in these processes, and serious poisoning cases have resulted. These solvents should not be used in quantity in fulling operations; dichlorethyl ether on account of its very high toxicity, carbon tetrachloride on account of its great volatility and relatively high toxicity. Another highly toxic substance, tetrachlorethane, was said to be a constituent of certain tar removers. This solvent should also be used sparingly.

Cases of illness ascribed to xylol and hi-flash naphtha were reported, but none of these were fatal. The room where the No. 3 group of tests were made was provided with artificial ventilation. In spite of this, vapor concentrations as high as 300 parts per million for periods of 30 minutes or over were found. It is readily seen that without such ventilation hazardous concentrations of even these slightly volatile and moderately toxic vapors might be set up.

Concerning the use of o-dichlorbenzene, it is impossible at the present time to make any definite statement. So far as is known there have been no cases of industrial poisoning resulting from its use. A recent study by G. R. Cameron and others (J. Path. and Bact., XLIV, 2, p. 281, Mar., 1937), however, resulted in the conclusion that "We consider it inadvisable that human beings be exposed to (its) influence even in low concentrations, for any length of time". Single 24-hour exposures to 50 parts per million caused liver necrosis in all the mice and rats exposed in their study.

DUST DETERMINATIONS

In two mills the dust in the carding room atmosphere was determined. The results are shown in the following table:

No.	No. Tests	Dust Determinations		
		Dust Found, Mg. per Cubic Meter of Air		
		Maximum	Minimum	Average
1	4	23 mg.	3.5 mg.	9.2 mg.
2	5	9 mg.	Trace	2.4 mg.

The physiological effects of wool dust are apparently not definite, but it would probably have a somewhat irritating action. The threshold concentration is not known.

CONCLUSION

Skin irritants are the most widespread health hazard in the woolen and worsted goods industry. Systemic health hazards include ammonia and the solvents used in fulling operations as tar removers. Processes involving these substances should be well ventilated, and highly toxic solvents, such as dichlorethyl ether, should not be used in large quantities.